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(54) Guiding outwardly opening valves in fuel injectors

(57) The valve stem 21 is provided with a first guide portion 22 and a second guide portion 30 and the diametral clearance between the outermost portion of the valve head 20 and the bore 18 is less than the clearance between the second guide portion and the bore but greater than the clearance between the first guide portion and the wall of the bore. This is to minimise the risk of the clearance between the head and the bore becoming blocked by carbon deposit. The clearances may be respectively 15, 20 and 10 microns.

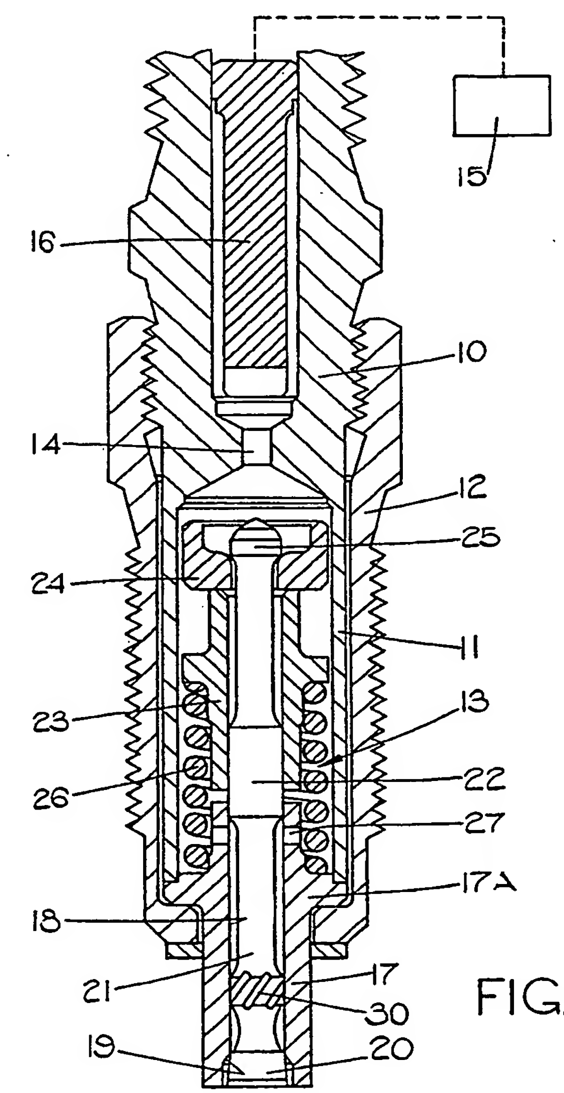

FIG. 1.

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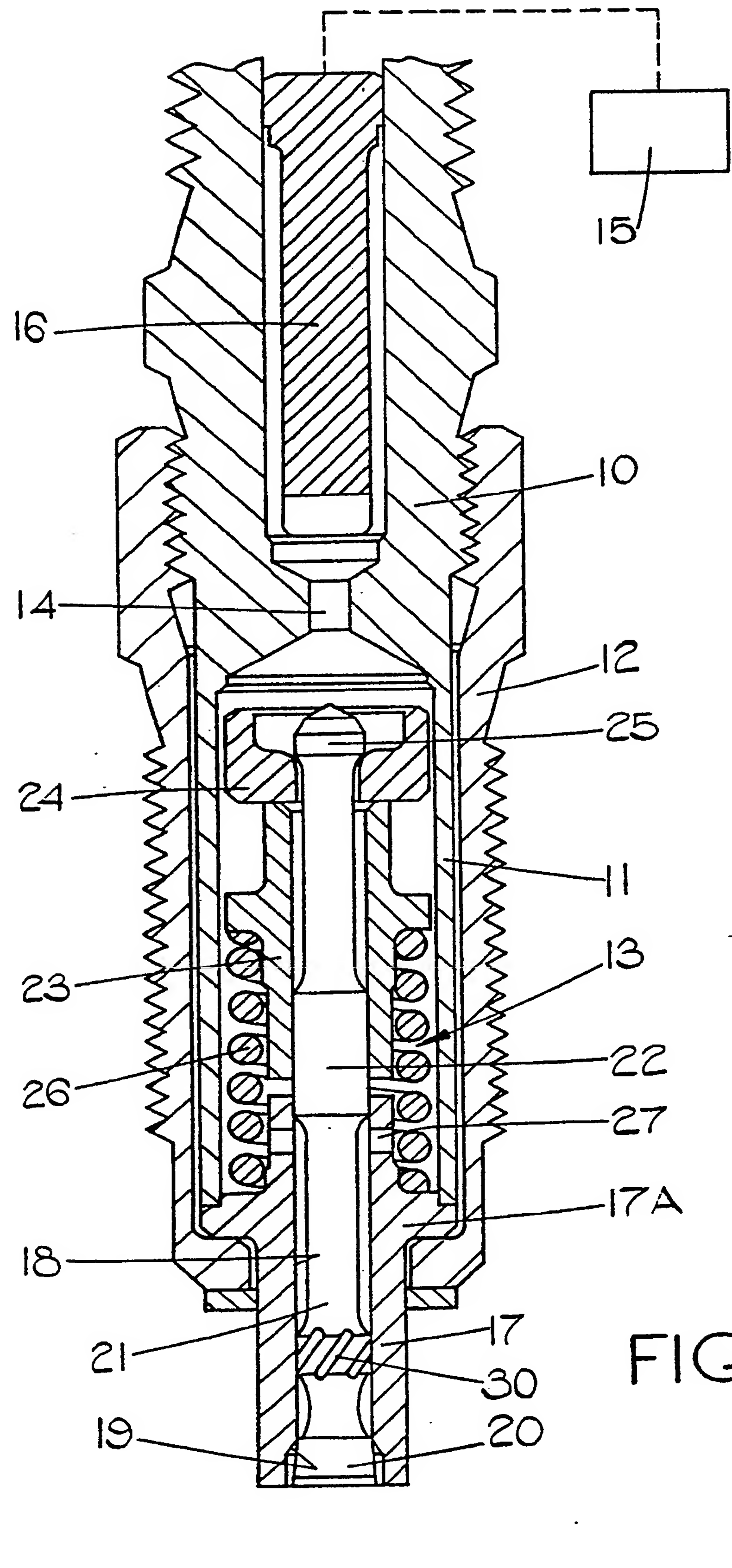

FIG.1.

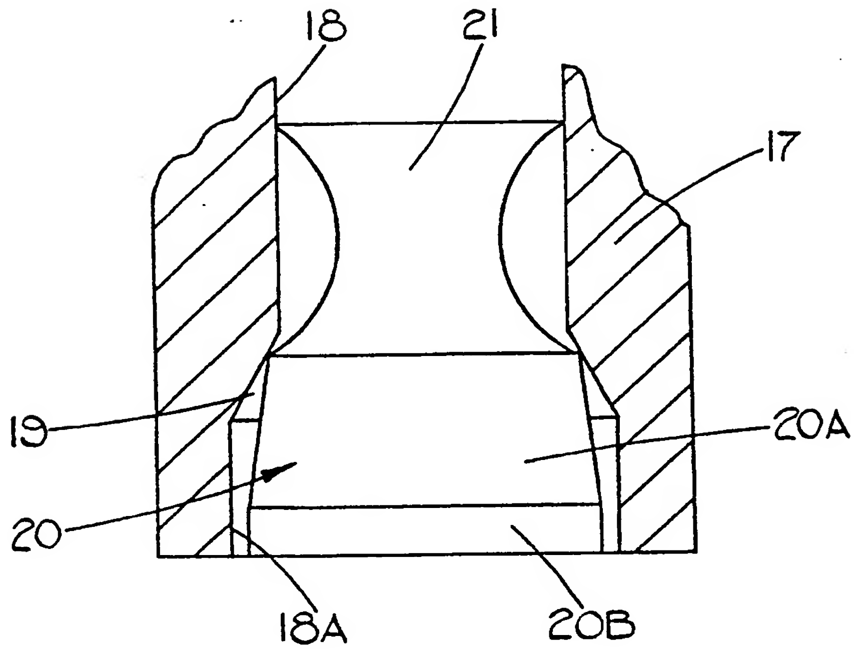

FIG.2.

SPECIFICATION

Fuel injection nozzles

This invention relates to fuel injection nozzles of the so-called outwardly opening type and which comprise a nozzle body having a bore extending therethrough, a seating defined in the bore adjacent one end thereof, a valve member axially movable within the bore, said valve member defining a head for co-operation with the seating and resilient means acting on the valve member to bias the valve head into contact with the seating.

Many forms of such nozzle are known in the art and in operation, fuel under pressure acts upon the valve member to urge the valve head away from the seating thereby to allow flow of fuel through an annular clearance defined between the head and the bore. A known form of such a nozzle has the seating spaced inwardly from the end of the bore at the junction of the main portion of the bore and a portion of the bore having a slightly larger diameter. The latter portion of the bore accommodates the head of the valve member which it is known to provide with a right cylindrical portion which has the surface spaced from the wall of the enlarged portion of the bore to define an annular clearance through which the fuel flows when the head is lifted from the seating. When the head is lifted fully from the seating the right cylindrical portion of the valve head may be completely removed from the enlarged portion of the bore.

It is also known to modify the shape of the valve head to alter the shape of the spray pattern produced by the nozzle. For example, it is known to provide a deflector at the end of the valve head and upon which in use, impinges the jet of fuel flowing through the clearance. The deflector has a diameter which is larger than the aforesaid enlarged portion of the bore and it presents an outwardly inclined surface to the jet so that the spray is deflected away from the axis of the nozzle. The deflector may be provided with an axial groove or grooves so that a portion or portions of the jet passing through the clearance will be unaffected by the deflector. In another example a portion of the valve head projects beyond the end of the body in the closed position of the valve member and is provided with a circumferential groove having inclined sides. The overall diameter is the same as the cylindrical portion of the valve head but the effect is to modify the fuel spray produced by the nozzle. In another example the valve head lies substantially flush with the end of the nozzle body in the closed position of the valve member and the groove is formed in the cylindrical portion of the valve head.

The nozzles as described are made as small as possible in order that they can be accommodated in the cylinder head of an engine and as a result the clearance through which the fuel flows is very small. Since the clearance is positioned downstream of the seating considered in the direction of fuel flow, there is a tendency for the surfaces of the valve member and the wall of the enlarged portion of the bore to become coated with carbonized fuel which reduces the working clearance and may eventually cause sticking of the valve member so that the nozzle no longer functions in the required fashion.

The object of the invention is to provide a nozzle of the kind specified in a simple and convenient form and in which the risk of carbonization of the surfaces of the bore downstream of the seating and the surfaces of the valve head is minimised.

According to the invention in a fuel injection nozzle of the kind specified the valve member has a stem extending through the bore, a portion of the stem removed from the head defining a first guide portion which co-operates with the wall of the bore to guide the movement of the valve member, the stem defining a second guide portion disposed between the first guide portion and the head, said guide portions and the wall of the bore defining working clearances, the working diametral clearance defined between the second guide portion and the wall of the bore being greater than the working diametral clearance defined between the first guide portion and the wall of the bore and greater than the diametral clearance defined between a surface of the valve head downstream of the seating and the wall of the bore.

An example of a fuel injection nozzle in accordance with the invention will now be described with reference to the accompanying drawings in which:—

Figure 1 is a sectional side elevation of the nozzle and

Figure 2 is a view to an enlarged scale of a portion of the nozzle seen in Figure 1.

The nozzle comprises a body part 10 which has an integral skirt portion 11. The body part has a peripheral screw thread with which is engaged a cap nut 12 which retains a nozzle assembly generally indicated at 13, in engagement with the end of the skirt.

The skirt portion defines a chamber with which communicates a fuel inlet passage 14 the latter in use being connected to the outlet of a fuel injection pump indicated at 15. An edge filter member 16 is provided in the fuel inlet.

The nozzle assembly includes a nozzle body 17 having a flange 17A which is trapped between the end of the skirt portion 11 and the cap nut 12. Extending through the body 17 is a cylindrical bore 18 and as shown in Figure 2 the end portion 18A of the bore has a slightly larger diameter so that a seating 19 is defined. For engagement with the seating there is provided the head 20 of a valve member which has a stem 21 extending through the bore. The stem is provided with a first guide portion 22 and between the guide portion 22 and the valve head, a second guide portion 30 which is fluted. The guide portion 22 mounts a spring abutment 23, the abutment being retained upon the stem by means of a retainer 24 which is located upon the stem by means of a retainer 24

which is located about a reduced portion of the stem and which engages a projection 25 formed at the end of the stem remote from the head. The abutment 23 has an outwardly extending flange with which is engaged one end of a coiled compression spring 26 the other end of which engages the flange 17A. The nozzle body 17 is provided with a pair of ports 27 through which fuel can flow from the chamber defined by the skirt portion along the annular clearance defined between the stem 21 and the bore 18. The guide portion 30 is fluted to allow fuel to flow when the valve head is lifted from the seating, through the clearance defined between the valve head and the seating.

As shown in Figure 2 the valve head 20 has a tapered portion 20A and a right cylindrical portion 20B.

In use, when fuel under pressure is supplied by the injection pump, the fuel pressure acting upon the valve member lifts the head from the seating so that fuel can flow through the annular clearance defined between the enlarged portion 18A of the bore and the right cylindrical portion 20B of the valve member. The fuel becomes atomised as it leaves the clearance. As the valve head moves away from the seating the area of the flow path begins to increase as the right cylindrical portion 20B moves out of the enlarged portion 18A of the bore.

When the flow of fuel ceases the head of the valve member returns under the action of the spring and also under the action of the pressure within the combustion chamber of the engine so that it contacts the seating 19. Some fuel will however remain in the clearance defined between the valve head and the enlarged portion of the bore and in use, this fuel will tend to become carbonized so that the surfaces of the bore and the valve head will be coated with carbon.

In order to minimise the build-up of carbon on the aforesaid surfaces, the working clearances between the first and second guide portions and the wall of the bore together with the clearance between the right cylindrical portion of the valve head and the enlarged portion of the bore are carefully controlled.

The diametral clearance between the right cylindrical portion 20B and the enlarged portion 18A of the bore is determined by the required operating characteristics of the nozzle and in a particular example the diametral clearance is 15 microns. The working diametral clearance between the second guide portion and the wall of the bore is arranged to be greater than the diametral clearance between the head and the enlarged portion of the bore whilst the working diametral clearance between the first guide portion of the wall of the bore is arranged to be less than the diametral clearance between the valve head and the wall of the enlarged portion of the bore. In an example, the diametral clearance between the first guide portion 22 and the wall of the bore is 10 microns whilst the working clearance between the second guide portion 30 and the wall of the bore is 20 microns.

With the modification of the working clearances as described it is found that there is a reduced tendency for carbonization of the surfaces to occur. The reason for this is not fully understood but it is thought to be due to the fact that the head of the valve member is not accurately guided and can therefore move laterally so that any carbon deposited tends to be removed.

Claims

1. A fuel injection nozzle of the so-called outwardly opening type comprising a nozzle body having a bore extending therethrough, a seating defined in the bore adjacent one end thereof, a valve member axially movable within the bore, said valve member defining a head for co-operating with the seating, resilient means acting on the valve member to bias the valve head into contact with the seating, the valve member having a stem extending through the bore, a portion of the stem removed from the head defining a first guide portion which co-operates with the wall of the bore to guide the movement of the valve member, the stem defining a second guide portion disposed between the first guide portion and the head, said guide portions and the wall of the bore defining working clearances, the working diametral clearance defined between the second guide portion and the wall of the bore being greater than the working diametral clearance defined between the first guide portion and the wall of the bore and greater than the diametral clearance defined between the surface of the valve head downstream of the seating and the wall of the bore.

2. A nozzle according to Claim 1 in which the second guide portion is fluted to allow fuel flow.

3. A nozzle according to Claim 1 or Claim 2, in which the diametral clearance between the valve head and the wall of the bore is 15 microns, the diametral clearance between the first guide portion and the wall of the bore is 10 microns and the diametral clearance between the second guide portion and the wall of the bore is 20 microns.

4. A fuel injection nozzle substantially as hereinbefore described with reference to the accompanying drawings.

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